Volume 31 December, 1945 *Number 12*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication in
Low Temperature
Refrigeration

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Lubrication in Low Temperature Refrigeration

WHAT'S IN PROSPECT

SOMETIMES it is interesting to look into the past; to predict the future; to remember the days when the refrigeration industry built one million household units a year; to review the interest in air conditioning; to note that only some 11,000 homes were air conditioned in 1940. In fact, looking further into the need for air conditioning, the September 25, 1944 issue of Air Conditioning and Refrigeration News, stated:

"90% of the department stores, 95% of the office buildings, 98% of the small stores and service establishments, 85% of the hotels, 80% of the hospitals and 75% of the railroad passenger cars are still without air conditioning."

THE TRENDS IN CONSTRUCTION

In post-war refrigeration, the trends are expected to be toward,

a—Compressors operating at higher speeds to reduce the weight and size.

b—Units operating at higher condensing pressures to permit use of refrigerants such as "Freon-22" where desirable.

c—A greater proportion of the new equipment designed to operate at lower temperatures to handle frozen foods.

d—More sealed motor-compressors, self-contained and factory assembled, so that field installation and service work can be reduced.

DESIGNING FOR LUBRICATION

Refrigerator compressor lubrication has always been studied with regard to its relation to capacity and efficiency. This holds true regardless of the type of lubricating system employed. There must be adequate lubrication, but not a continued excess, for immediately this latter occurs, the possibility of oil slugging will develop.

Methods of Lubrication

The intricacy of the lubricating system will depend upon the type and capacity of the compressor. The centrifugal machine requires the least complex system since there are only the bearings of the rotor to be lubricated. These are taken care of by ring oilers. Simultaneously, however, the oil performs an additional function in maintaining an automatic oil seal against loss of vacuum.

Reciprocating or rotary compressors, on the other hand, present more parts to be lubricated and require circulation of the oil. This is accomplished by splash or force feed. The former is particularly applicable to the fractional tonnage units so widely used for household refrigeration. While the idea parallels automotive practice, some very unique means have been provided by certain manufacturers to assure of positive circulation especially to the cylinder walls.

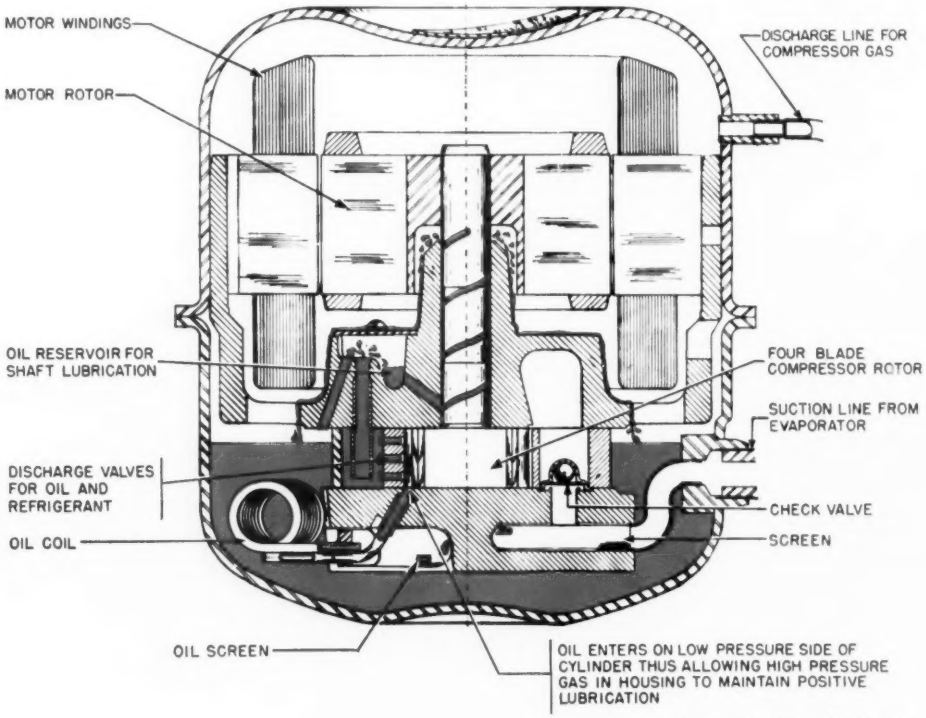
The Use of Splashers

Splash lubrication is devoid of the possibility of starved lubrication provided the compressor parts are designed for thorough circulation of the oil after this is begun by the crank splash elements. All that is necessary usually, is to maintain a suitable oil level to enable the splashers to dip to a sufficient extent at each throw of the crank-shaft.

Pressure Systems

With the advancements in heavier tonnage design to meet the requirements of commercial re-

frigeration and air conditioning, the adaptability of pressure became the subject of considerable research, designed to function either alone or together with splash. Here the objective was to obtain positive circulation of oil throughout the compressor and to eliminate foaming as far as possible. Obviously, in a splash lubricated reciprocating compressor, foaming will always be present. The extent to which it may be objectionable will depend upon the oil level, and the location of the suction valves. Inasmuch as the unit type of compressor usually takes its suction through the crankcase, if the foam level rises to a sufficient degree, foam may be carried over to the high side with the refrigerant to seriously retard heat transfer. Ultimately, if allowed to continue, cleaning of the system may be necessary. The attendant expense is, of course, objectionable. To obviate this some builders have arranged their design so that all refrigerant gases and vapor are excluded from the crankcase.


MOTOR WINDINGS
MOTOR ROTOR
DISCHARGE LINE FOR COMPRESSOR GAS
OIL RESERVOIR FOR SHAFT LUBRICATION
FOUR BLADE COMPRESSOR ROTOR
SUCTION LINE FROM EVAPORATOR
DISCHARGE VALVES FOR OIL AND REFRIGERANT
CHECK VALVE
OIL COIL
SCREEN
OIL SCREEN
OIL ENTERS ON LOW PRESSURE SIDE OF CYLINDER THUS ALLOWING HIGH PRESSURE GAS IN HOUSING TO MAINTAIN POSITIVE LUBRICATION

Courtesy of Seeger-Sunbeam Corporation

Figure 1 — In the Sunbeam hermetic compressor, oil for lubrication is held in the bottom of the housing and admitted to the compressor through the oil line. The oil enters the cylinder at a point where compression is just beginning, giving a pressure differential between the oil in the housing and the inlet to the cylinder, thus maintaining a positive flow of oil. Oil is discharged with the compressed gas into a space above the oil reservoir, which remains full from this discharge. This reservoir supplies oil to the shaft spiral which carries the lubricant to the top bearing. The overflow is returned to the bottom of the housing.

Pump Design

Some most interesting advancements have been made by the industry in perfecting pumping devices for positive handling of lubricating oil throughout the compressor mechanism. The trend is definitely towards controlled lubrication, especially where dealing with refrigerants which are miscible with mineral lubricating oils. This has required consideration of strainers and oil separators along with pump design. All are more or less related to compressor efficiency and capacity, viz., a continued excess of oil will lead to slugging and reduction in efficiency, yet there must be a slight excess on starting to assure of positive lubrication of piston and cylinder walls, especially in the reciprocating machine. This can be assured by proper pump adjustment.

The Gear Pump

This element—an offshoot from automotive practice, has been proved to be as equally dependable in refrigerator compressor service. The gear pump as designed for positive delivery of oil, is a comparatively simple device, consisting of a pair of gears mounted in a suitable housing. The normal

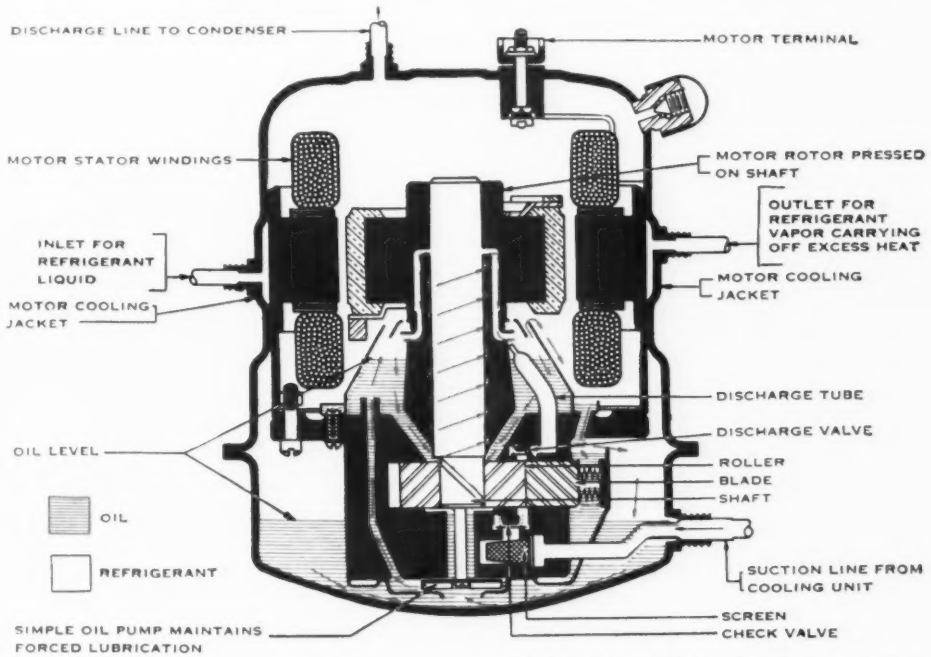
location of such a pump is in the base of the crankcase of the compressor. Some designers prefer to place this pump at the lowest part of the case; others are of the opinion that the pump should be set just above a depression or catch basin in the case to provide means for trapping foreign matter and preventing it being circulated through the lubricating system. Usually, however, there will be a negligible amount of foreign matter in a well-designed system using properly refined oil.

TESTS USED TO INDICATE THE SUITABILITY OF THE OIL

Pour Point Test

Refrigerator oils are manufactured to pour points* ranging from −15°F. to −45°F. varying with the viscosity and type of oil. More recently with the trend toward temperatures approaching −100°F. in deep-freeze work, metals assembly and medicine, very low wax separation point has also become a factor. The pour point is associated with the wax content and viscosity of the oil. In other words, as either of these increase, they will tend to raise the pour point. With some oils the recorded pour point may be due to both the wax content and the viscosity, or to the viscosity alone; in the case of the latter, the term "viscosity pour" is used. Oils derived from naphthenic base crudes will ordinarily show a "viscosity pour" as these by their nature contain very little if any wax.

The sequence of manufacture is of distinct interest and exceedingly important in obtaining oils with desired pour point test properties. After careful segregation of the crude to balance the relative value of its other characteristics against the benefits of low pour point, it is run to produce a lubricating fraction. This lubricating fraction, which is normally a distillate in the case of refrigerator oils, is then subjected to intensive chemical treatment and filtration. Economic studies have shown that refrigerator oils are produced most economically from naphthene base crudes, although recent developments in solvent dewaxing and refining have indicated the practicability of starting with a paraffin base crude and arriving at similar objectives by using various combinations of these two processes.



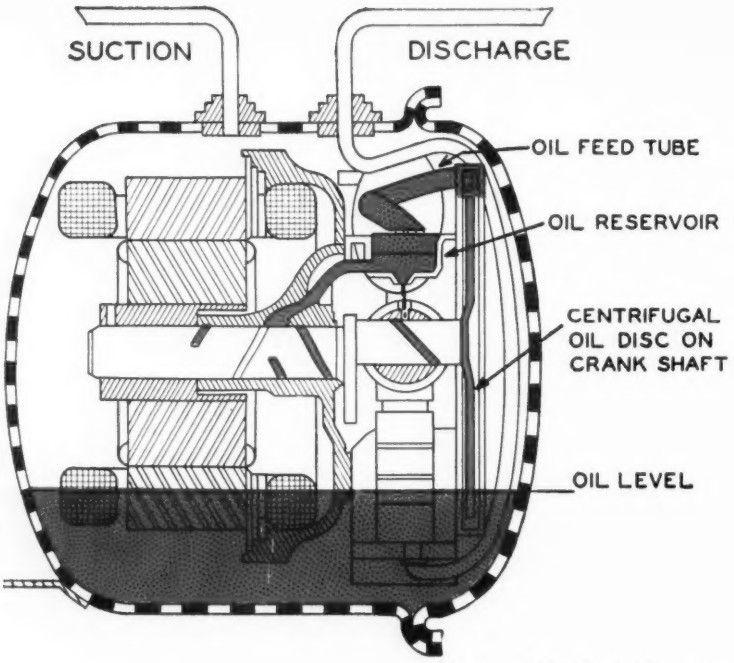
Courtesy of Norge Division, Borg-Warner Corporation

Figure 2 — Cycle diagram of the Norge hermetic refrigerating unit. The main body of oil is contained in the lower part of the casing. A simple vane pump lifts it to the reservoir above the pump proper. From here oil flows by gravity to an annular passage surrounding the shaft at the top of the eccentric. The eccentric bearing is served by oil via spiral grooving which also carries lubrication to the upper shaft bearing. Arrows indicate course followed by the oil.

"Wax" Floc

"Wax" Floc is variously interpreted as the temperature at which a 10% oil—90% refrigerant mixture, when chilled, changes from clear to hazy; or,

*See A.S.T.M. Standard Method of Test (D 97-39) in 1944 Book of A.S.T.M. Standards, Part III, p. 115, "Method of Test for Cloud and Pour Points."



Courtesy of The Crosley Corporation

Figure 3 — Section details of the Crosley compressor. A revolving disc pumps oil up to a reservoir via an oil feed tube, whence it flows to the bearings and then back to the oil sump.

the temperature at which the mixture develops a definite floc.

The manufacture of wax-free oils has become increasingly important with the adaptation of refrigeration machinery to temperatures considerably below the conventional 0° to −25°F. usage range of a few years ago. When a compressor, its lubricating oil, the expansion valve and other parts must function at temperatures around −80 to −100°F. or lower, it is important to consider the presence of any material in the oil which would congeal to interrupt the refrigeration cycle.

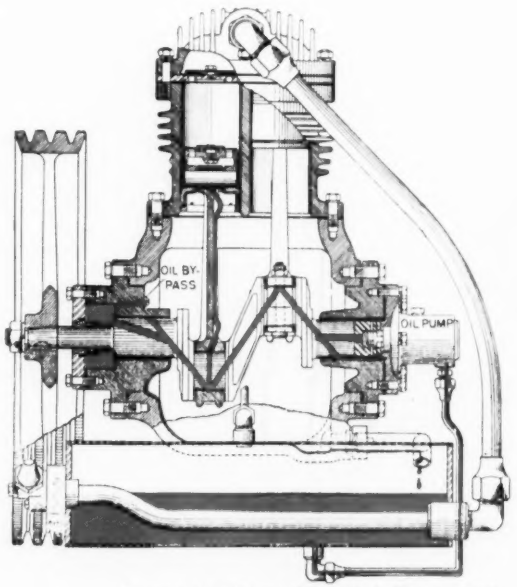
The petroleum chemist has spent much time in recent years studying hydrocarbons which would tend to congeal and solidify in the oil when exposed to very low temperatures. There seems to be no direct relation between the usual physical tests of these hydrocarbons and the pour test. Two refrigeration grade oils may have practically the same physical characteristics including pour point, yet one may show a "wax" floc from twenty to thirty degrees lower than the other. Obviously it is desirable to remove objectionable wax-like hydrocarbons in the course of refining the oils. This is the objective in modern refinery practice. When more positive information is available as to their true identity the economics of the refining procedure may well be affected.

R. J. Thompson and W. W. Rhodes of Kinetic Chemicals, Inc., in discussing "Freon-22" have suggested some pertinent thoughts. Should oil separation, wax separation and accumulation of wax at the low temperatures required, be experienced, they state:—

1—Use an oil as low in viscosity as is practical for satisfactory compressor operation.

2—Use an oil which has been dewaxed or degummed at a sufficiently low temperature so that any remaining wax will not be precipitated out of the oil at the lowest operating temperature when the oil is in solution with liquid "Freon-22".

3—Install an oil separator between the compressor and the condenser and as close to the cylinder head as possible, so as to prevent the oil containing wax passing through the condenser, receiver, liquid line, expansion valve, and into the low temperature evaporator.



Courtesy of Williams Oil-O-Matic Heating Corp.

Figure 4 — The Williams Ice-O-Matic Compressor showing the pressure lubrication system. The oil pump is of the rotary gear type. Use of an auxiliary oil tank gives a "dry" crankcase. The pump circulates this oil as indicated.

Water

Water in a refrigerator oil can exert several bad effects:

1—It can throw off the accuracy of the floc test by creating a false cloud.

2—It can contribute to chemical reaction with some refrigerants; or,

3—It can become a potential cause of stoppage due to formation of ice particles at the expansion or regulating valve.

Water can be removed from the oil before the latter is charged to the refrigerating unit by blotter pressing which assures of complete removal of suspended moisture from a new oil. For extreme low temperature service, where it may be desired to remove even dissolved moisture at the time of charging the system with oil, this can be done by vacuum dehydration at elevated temperatures assisted by dry air or nitrogen. Where a refinery-dehydrated oil has been purchased the storage must be so planned that the oil will not be exposed to air containing moisture. Petroleum oils readily absorb moisture from the air; a refrigerator oil, therefore, must be most carefully handled.

The Chemical Effect of Water

In an SO_2 system water will react with the refrigerant to form a corrosive acid which can attack certain of the metallic parts of the system.

Water is serious in a methyl chloride system as it may produce corrosion products due to slow reaction of the methyl chloride with water to form hydrochloric acid. Water also can promote "sludge" formation and copper "plating". It is regarded by authorities as the chief offender in regard to copper "plating".

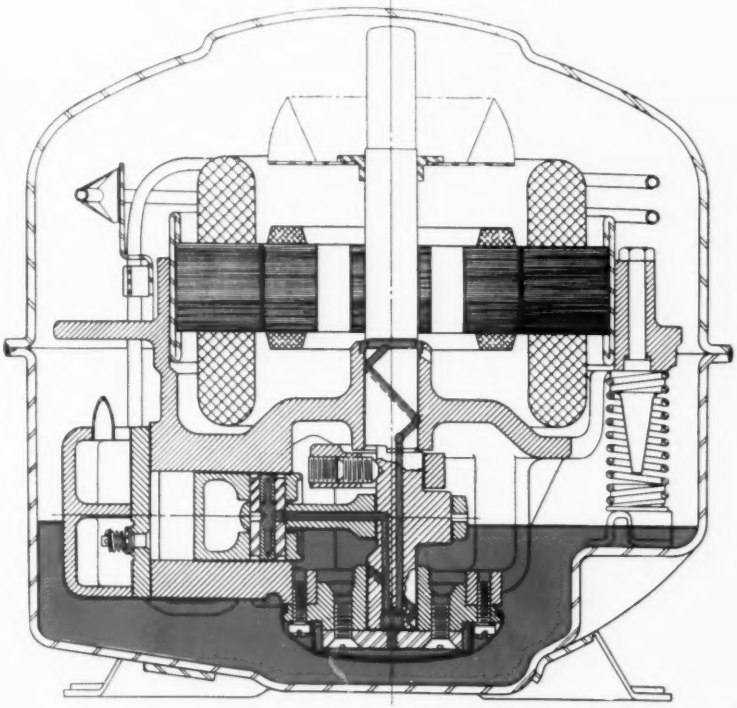
In systems using any of the "Freon" refrigerants, water beyond the point of saturation may promote reaction to corrosion products. Over long periods of time these refrigerants may slowly react with water to develop acid products to perhaps a sufficient extent to present a corrosion problem.

*See A.S.T.M. Standard Method of Test (D-117-43) in 1944 Book of A.S.T.M. Standards, Part III, p. 443, "Tests for Electrical Insulating Oils," Dielectric Strength.

*Significance of the Dielectric Strength**

A high dielectric strength is today used as an indication that a refrigerator oil will not contain moisture to such an extent as to cause trouble. While the dielectric strength does not indicate moisture content in terms of percentage by weight, there is some correlation between the two, i.e., an oil of some 30,000 volts dielectric strength may contain as much as 0.01% moisture by weight, a 25,000 volt oil may contain as much as 0.03% moisture by weight.** Separation of any of this dissolved water by a slight drop in temperature will immediately lower the dielectric strength to 10,000 volts or lower. These quantities in ultra-low temperature refrigeration can be considered harmful. Satisfactory methods of determination of dissolved moisture contents are an industry need. F. M. Clark of General Electric Co. has contributed some pertinent thoughts in this regard.***

Although the dielectric test has been adopted as one of the standard tests under which refrigerator oils are purchased, it is in reality a premium test,

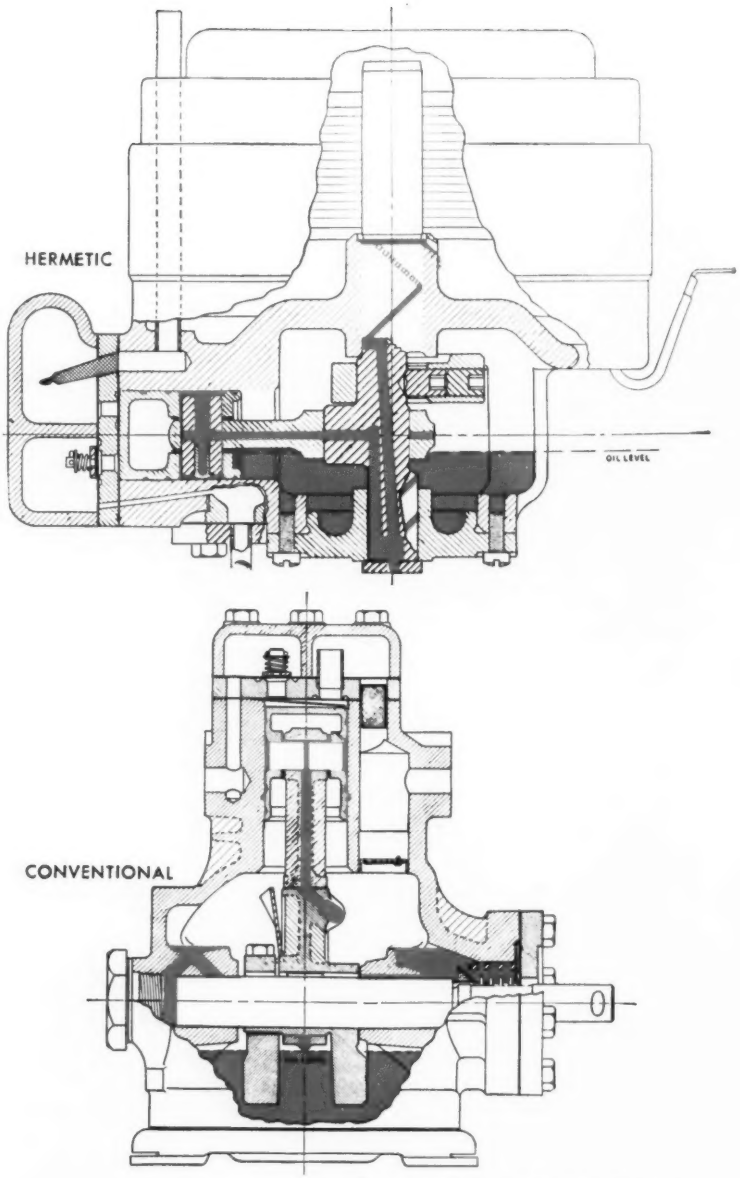


Courtesy of Admiral Corporation

Figure 5—Cross section of the Admiral "Cold Master" Compressor showing lubrication circuit in red.

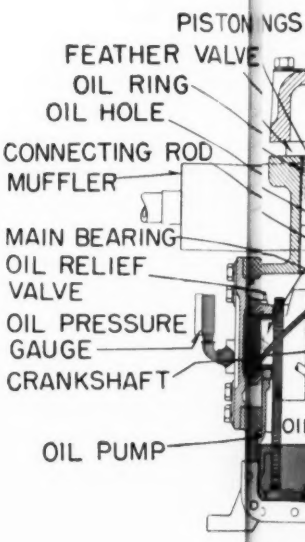
**Artic Service News—E. I. duPont de Nemours Co., Mar. 1939, p. 2.

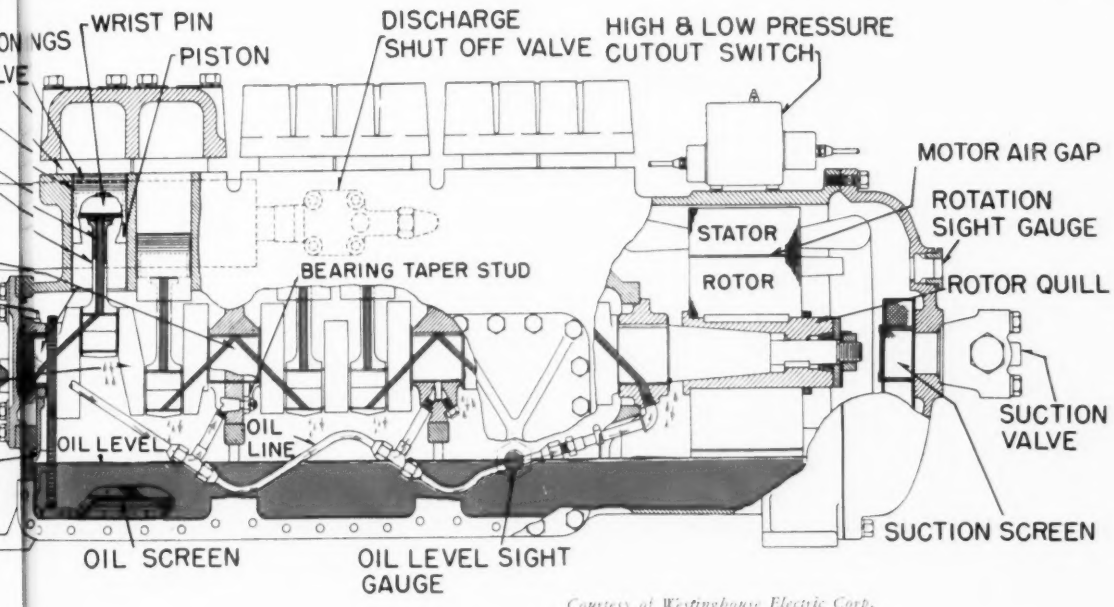
***Water Solution in High-Voltage Dielectric Liquids—by F. M. Clark, General Electric Co. Paper before Am. Inst. of Electrical Engineers. Published in Electrical Engineering, August, 1940.



Courtesy of Tecumseh Products Company

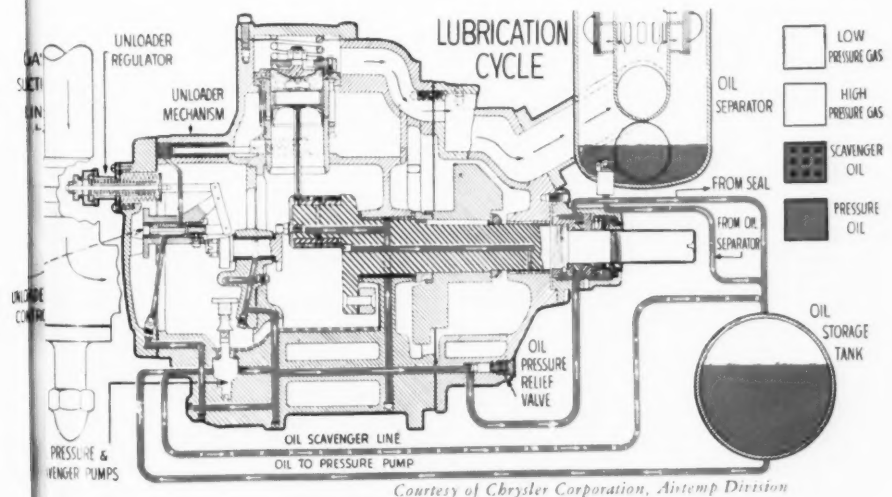
Figure 6 — Details of the Tecumseh hermetic and conventional refrigerating units showing the lubricating systems. In the former, full force feed lubrication is provided to all parts; in the conventional machine, force feed oiling applies to the eccentric, connecting rod, wrist pin, and piston.





Courtesy of Westinghouse Electric Corp.

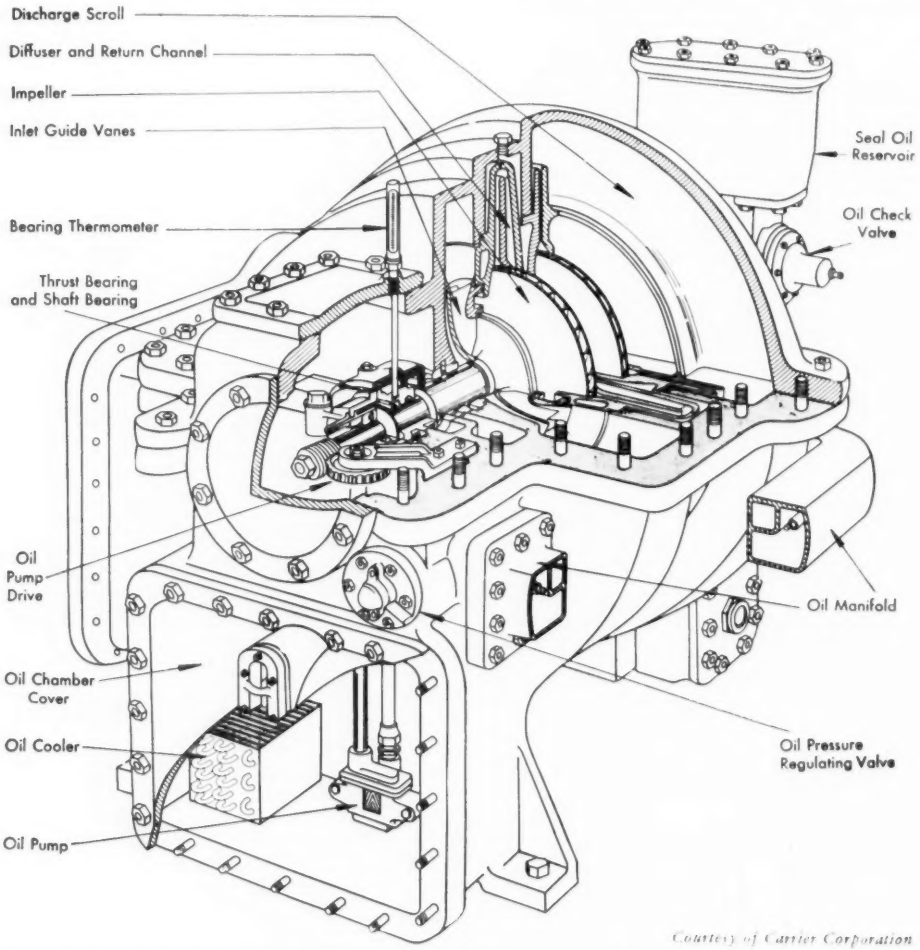
Figure – Internal construction of the Westinghouse type CLS-850 condensing unit. In this device the motor is hermetically enclosed and cooled by the refrigerant gas returning from the evaporator. The oil pump is mounted on the end ling opposite the motor end of the compressor. Via drilled crankshaft and connecting rods, full pressure lubrication is developed throughout the machine.



Courtesy of Chrysler Corporation, Airtemp Division

Figure 8 — Lubrication cycle for the Chrysler Airtemp Radial Compressor. Pressure lubrication ensures long bearing life. The rings and cylinders are protected by a mist of oil developed as oil under pressure escapes from the bearing.

to obtain which the buyer must pay an added cost per gallon. This is justified for refrigeration service work where oils are purchased in one quart or one gallon refinery sealed cans for usage in the field where little if any left-over remains after the seals on the cans have been broken and a machine has received a new charge of oil. By careful handling and minimum exposure to the air while charging the compressor the chance of the oil going off-



Courtesy of Carrier Corporation

Figure 9 — Oiling circuit for a Carrier centrifugal refrigerating compressor. Only four parts of this machine have rubbing or wearing surfaces: the shaft bearing, thrust bearing, oil pump and shaft seal surfaces. Long life of these parts is assured by positive lubrication. Note the oil pump submerged in the reservoir and the oil cooler to control the oil temperature.

dielectric by taking up moisture or dirt is remote.

But now consider the manufacturer who buys his refrigerator oil in bulk — in drums or tankcars. Drums can be refinery sealed just like cans, but tank cars have to breathe so outage is left in the dome for expansion. Also, expansion space is left in drums.

When such shipping containers are filled, it is no problem for the oil refiner to blotter press to a 25,000 volt dielectric. However, this costs money. The refrigeration machinery builders ultimately pay this cost. Yet, some of them re-blotter press their oils after receiving them, or otherwise make sure that they are dry before charging their compressors. In turn, some of these builders have realized that they are paying an unnecessary premium for a high dielectric strength oil, when it is such a simple matter to blotter press or dehydrate in their own plants. These builders have found they do not need to purchase on a 25,000 volt dielectric specification upon delivery. This does not free the refiner from any responsibility in delivering a high quality refrigeration grade oil, but an economic benefit accrues to all concerned, since it eliminates the necessity for specially built tank-cars or bulk containers

from which all moisture-laden air, all dust, rust, etc., can be completely excluded during filling and shipment to destination. Upon arrival the same stringent precautions must be observed while unloading and in bulk storage of the manufacturer if the high dielectric strength is to be maintained. All this would seem to be an unnecessary expense as well as a practical impossibility.

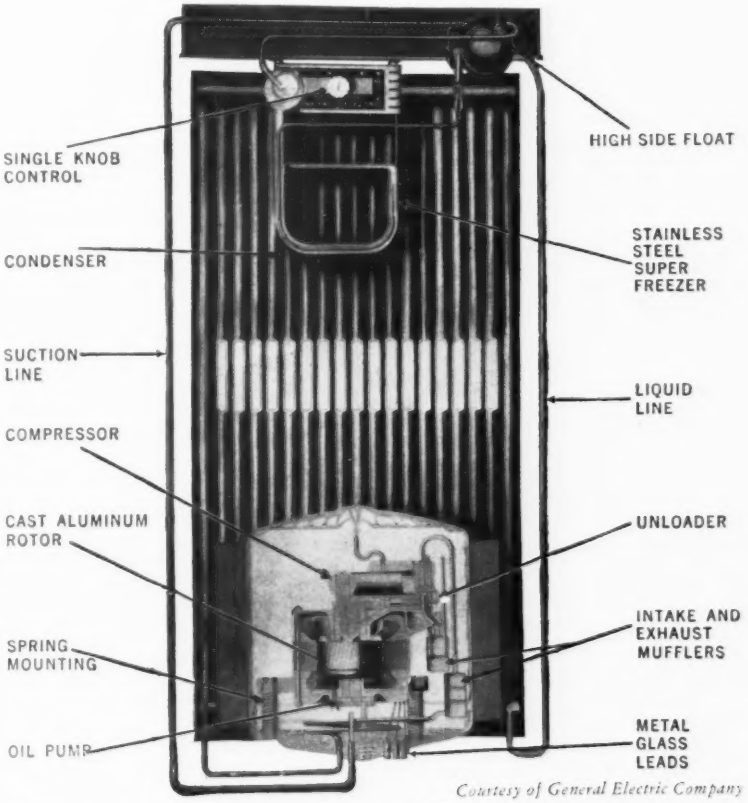
Relation to Moisture Solubility

Solubility of water in the oil is regarded as significant. Water in solution becomes water in suspension as the temperature of the oil is reduced due to temperature-solubility effect. Research has indicated that moisture present in an oil up to its saturation point has little if any effect on the dielectric strength. Presence of moisture above the saturation point, however, immediately causes considerable loss in dielectric strength. The temperature of course is a factor. If an oil is saturated with moisture at a higher temperature and the dielectric strength is run at a lower temperature, a low value will be obtained at the latter temperature, in contrast with a much higher value which may be observed at the higher temperature. This indicates the need for dehydration below any moisture content indicated by the dielectric strength test if the oils are to be used in ultra-low temperature service.

Viscosity-Reduction

The ease with which mineral oils will mix or go into solution with the chlorinated or fluorinated refrigerants has fostered a decided interest in the subsequent viscosity of the mixtures. In the beginning, it led to consideration of oils of somewhat heavier original viscosity than subsequent experience proved were necessary. The fact that a 300 viscosity oil would be reduced to an operating viscosity range in the crankcase of around 90 secs. Saybolt Universal at 100°F., by admixture with ten per cent* of "Freon" or methyl chloride, caused the skeptics to wonder as to the lubricating value of the mixture. To be on the safe side they raised the original viscosity of their oil in an effort to keep their operating viscosity at least 100 secs. at 100°F.

Others, more willing to investigate the lubricating value of lower viscosity oil-refrigerant mixtures, carried out exhaustive laboratory and service tests.

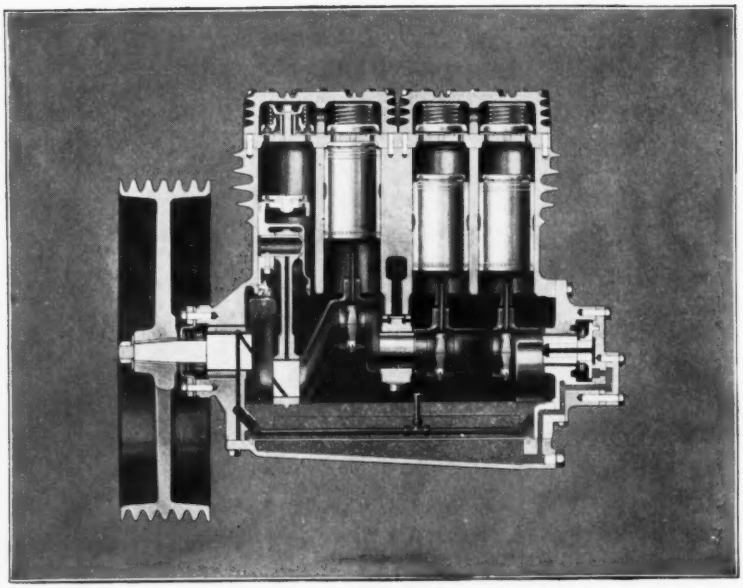


Courtesy of General Electric Company

Figure 10 — The General Electric refrigerating unit. The compressor is oiled by a two-blade oil pump which circulates oil from the base up through a passage in the center of the shaft. From this passage, smaller passages radiate to the lower shaft bearings and the yoke arrangement. The major portion of this oil goes to the self-aligning upper bearing, and from there to the unloader chamber. It then passes around a groove in the cylinder wall, and out. Part is then led down the inside of the case, the remainder flowing down over the cylinder and through the stator to cool the motor windings.

The resultant performance of the lighter viscosity refrigerator oils within say a range (undiluted) of 150 to 300 secs. Saybolt Universal at 100°F., has been convincing. It was definitely indicated that they were capable of affording entirely dependable lubrication even though the viscosity of the lubricating film was materially reduced by the refrigerant. This has justified the use of such oils by a number of builders who even went so far as to apply the same oil to both "Freon" and sulfur dioxide units. Before the war the practice was to use an oil of around 150 secs. Saybolt Universal viscosity for small refrigerating systems of the slow speed, en-

*The average ratio which prevails in the crankcase of the average compressor is around 10% refrigerant and 90% oil. The oil-refrigerant mixture at the evaporator is just the opposite. This is the reason why a mixture of 10% oil and 90% of "Freon" was adopted for the floc test, because this is the normal amount of oil which has been found to be carried over by the refrigerant after compression.



Courtesy Frigidaire Division, General Motors Corp.

Figure 11 — Showing a cut-away view of a four cylinder air conditioning compressor. All parts of this machine are designed for very accurate precision and lubrication is entirely automatic.

closed type, operating with a flooded evaporator; stepping up to around 300 viscosity for expansion systems. As speeds and loads were increased, an increase in viscosity was considered advisable. Viscosity up to around 500 secs. was desirable in such units. Capacity and type of compressor (whether air or water-cooled) principally will govern the viscosity of oil which should be used.*

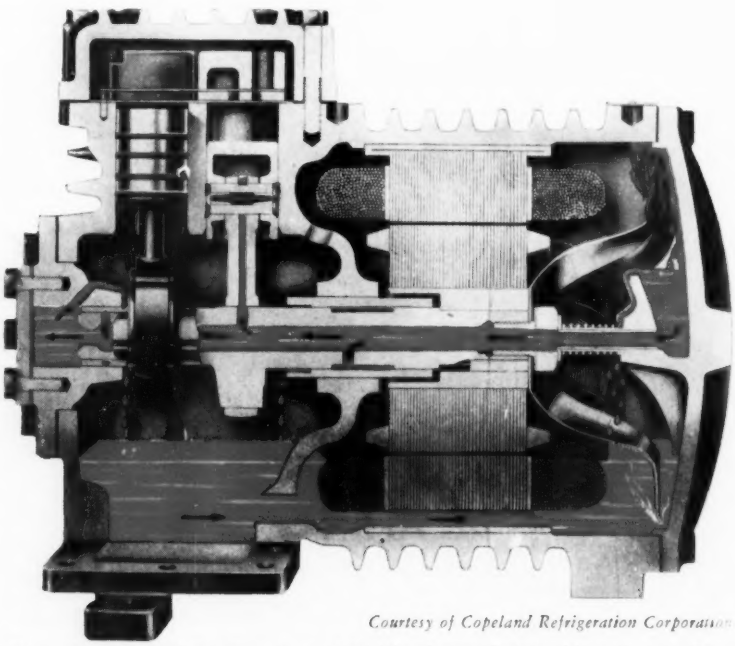
How Miscibility is Affected

In studying this matter of mutual solubility of mineral lubricating oils with "Freon" refrigerants, methyl chloride or the Carrenes, it is essential to understand that the physical nature of the refrigerant is all-important. In the liquid phase, all these refrigerants are entirely miscible with petroleum oils. When such refrigerants are in the gaseous phase, however, the oil being almost entirely liquid absorbs only a small portion of the gas. In other words, the respective refrigerant vapors will go into solution less readily, all dependent upon the prevailing pressures and temperatures. The petroleum technologist, in studying this phenomenon, endeavored to duplicate operating conditions as far as possible in the interest of improving lubrication, while at the same time, protecting the lubricating ability of the oil.

The amount of any such refrigerant which may be absorbed by a mineral oil will be dependent also upon the viscosity of the oil at the temperature of contact.

The viscosity bears a relation in that as it is increased the amount of refrigerant absorbed will decrease. In turn, larger amounts of "Freon", Methyl chloride and Carrene are absorbed by mineral oils at higher pressures and lower temperatures, just as smaller amounts will be absorbed at lower pressures and higher temperatures.

*R. J. Thompson, "Freon-12" Tech. Paper #11, Kinetic Chemicals, Inc., Wilmington, Del., p. 16, p. 17.

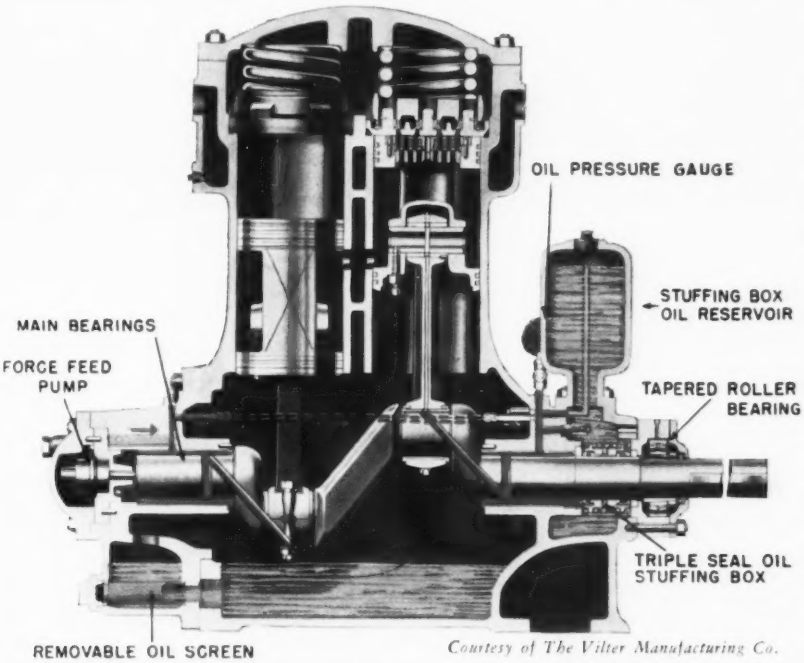


Courtesy of Copeland Refrigeration Corporation

Figure 12 — Details of the oiling circuit of the "Copelametic Twin" refrigeration unit. Their method of developing force feed lubrication without an oil pump is distinctive. A two-blade oil propeller, secured to the eccentric and rotor shaft dips oil, lifting it to keep a reservoir filled and overflowing above the shaft center line. Oil is drawn from this supply by centrifugal force into openings to bearings along the hollow eccentric shaft.

THE TREND TO LOWER TEMPERATURES

Stratosphere flying during the late war required more thorough knowledge of the performance of aircraft materials under temperatures ranging from −67°F. to −100°F. or even lower, and the effect of these temperatures upon human reactions. To be sure, flyers were not always directly exposed to such extreme cold as plane cabins were heated, but when bail-out was necessary, the crew had no control over the altitude at which they had to jump.



Courtesy of The Vilter Manufacturing Co.

Figure 13 — Cross section of a Vilter "Freon-12" compressor showing the force-feed oiling system and triple-seal. Vilter uses an automatic reversible gear type oil pump, as indicated, and a specially designed method of sealing the stuffing box by oil-flooding.

Stratosphere temperatures, therefore, were approached in most of the test units which were developed. These units will have a definite place in peace-time production. What research learned during the exigencies of war should be of even more lasting benefit thereafter. Medicine, metal assembly, petroleum research and precision mechanisms, all will profit.

In Medicine

Freezing of blood plasma down to temperatures around −100°F. was the first application of very low temperature to medicine. From a laboratory experiment it rapidly became a standard method of procedure during the late war. Shell freezing produces the best dried product. This is a process whereby the plasma is frozen on the inner surface of a bottle to form a layer or shell of plasma of uniform thickness.*

Research has also developed that surgical operations can be performed on human tissue by freezing the parts to be operated on down to around stratosphere temperatures. Local anesthesia by freezing is claimed to reduce the possibility of shock to nervous systems.

Refrigeration likewise has contributed to the production of Penicillin, being applicable to storage of the product after freezing, where temperatures around −70°F. are quoted.

In Metals Assembly

The aircraft industry proved the value of refrigeration in metals assembly, using aluminum, when their research people found that by chilling rivets and sheets down to around −50°F. or below to prevent age hardening, they could speed up materially the assembly of many fuselage and wing sections. Interesting physical changes in other metals occur when chilling or low-temperature quenching is practiced. Magnetic qualities are improved; hardness is increased and more permanent volume increase has been observed when the chilled parts have been brought back to normal temperatures — all related to the stabilization of metals. This is most important where strength, ductility and maximum wear resistance are desirable.

Temperatures as low as −130°F. are mentioned in the literature in connection with such work. It is predicted that −200°F. may be approached in the not too distant future. Considerable work is necessary to correlate the refrigerating system, the refrigerant and the lubricating oil in the interest of more dependable operation of the system as a whole.

Precision Mechanism

Instrument testing which came about as a result of stratosphere flying has gone beyond the scope of merely testing instruments for aircraft operation at stratosphere temperatures. Low temperature cold

*Lt. Col. D. B. Kendrick explained this method in detail before the annual meeting of the A.S.R.E. in Phila., Pa., Dec. 7, 1943.

rooms were perfected wherein pressures and temperatures could be accurately regulated so that radio equipment and other vital control devices could be tested under conditions virtually identical with those encountered in service. Low temperature cold rooms also enabled study of automotive and aircraft engine starting ability for Arctic service.

Function of the Cold Room

The cold room is a most important part in a petroleum research laboratory. Therein the petroleum technologist can study the performance of engine oils, fuels, gear lubricants and greases on full size equipment. Practical experience in the use of refrigerator oils in ultra low temperature service is thus available to the research personnel. For years before the war the cold room saved endless hours of winter research (uncertain at best); in the post-war period with cold rooms which can be chilled to nearly −100°F., petroleum research will keep pace with metallurgy, chemistry and refrigeration in producing lubricants which will function dependably at away below zero to away above.

PETROLEUM TECHNOLOGY CAME THROUGH

It was natural that all this low temperature requirement placed the petroleum industry in a tough spot at first. Refrigerating machinery was available to attain these temperatures. Refrigerants had been developed which made this economically practicable. Were lubricating oils available which would not stop up the expansion valves when the temperatures were reduced down to around −80° to −100°F.

Fortunately, refrigeration is an important function in the manufacture of petroleum lubricating oils. Cold treatment or chilling is employed in the removal of non-lubricating paraffinic wax hydrocarbons. The petroleum technologist, therefore, had available the ways and means to study the essential characteristics of refrigeration grade oils. He could direct his research toward the study of those hydrocarbons which precipitate out at very low temperatures. He could investigate their relation to moisture. He could confirm the opinions of authorities that moisture in any part of a refrigerating system is bad; what effect it may have upon the precipitating tendency of wax still is not too well known.

Where refrigerants are used which are in themselves dewaxing agents, there is still work to be done in establishing more dependable tests which will predict the suitability of the oil; i.e., how much wax is permissible? What is the minimum temperature of test? How can the machinery builders cooperate in designing their equipment to function more dependably at these temperatures in the evaporator on oils which will not require too drastic refining with attendant higher cost oils? What is the minimum and maximum operating viscosity? All this is not truly predicted by the pour point test of the oil itself or the floc test. The pour point is not a guide as it is made on the undiluted oil, and at very low temperatures the oil may cease to flow due to viscosity even though it may be wax-free.

With respect to the floc test, it has been demonstrated that one oil having a relatively high floc test, i.e., −30°F. may be entirely satisfactory at temperatures below −100°F., whereas another oil with a much lower floc test (−60°F.) may be entirely unsuitable at temperatures below −60°F. due to excessive wax precipitation. The floc test as run today on a 10% oil — 90% refrigerant is a good practical test but it requires interpretation.

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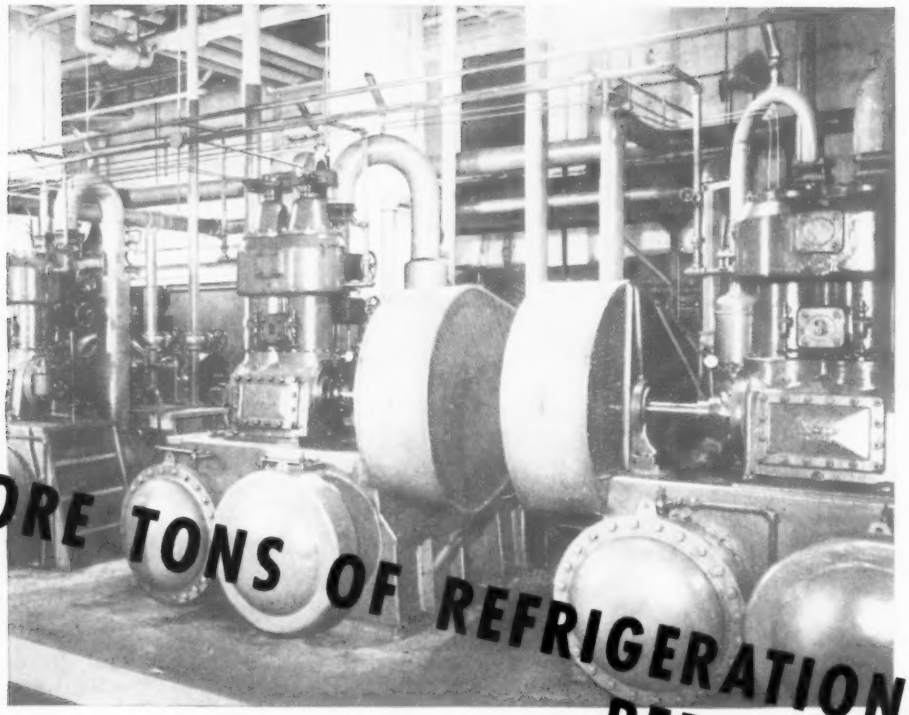

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